

## **Minor in sustainable design for engineering design education. Experience at UPC Barcelona Tech**

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### **ABSTRACT**

Sustainability and Internationalization are key factors within educational programmes and institutions nowadays. Offering programmes that focus on these factors at undergraduate level has been a priority at the School of Engineering of Vilanova i la Geltrú (EPSEVG), Barcelona, and since 2012, it has run the International Design Project Semester (IDPS) Erasmus mobility programme.

IDPS trains engineering design students by applying Project Based Learning in intercultural groups. The working language is English and the programme is designed for bachelor degree students in their 7<sup>th</sup> or 8<sup>th</sup> semester. The IDPS programme offered at the EPSEVG emphasises the introduction of competences in sustainability and human technology.

The main objective of the IDPS is to improve the learning outcomes and competences of industrial design engineering students especially in areas of Design for sustainability. It is divided into two parts. One part covers four (3 ECTS) credit core courses in specialist fields of study such as Eco Design strategies, Human Centred Design , Sustainable Design and Business Practicum, and the second part involves working on a project (18 ECTS). Additional seminars and workshops compliment the courses and vary from programme to programme. Local design companies and research groups propose the projects.

Since 2012, 43 students from 11 nationalities has participated in the IDPS working in nine real projects. This paper shows the design methodology used in the IDPS programme, its structure, the sustainability competences achieved by the students and the lessons learnt during the 5 years of the program.

Conference Key Areas: Sustainability and Engineering Education, Engineering Skills

Keywords: Engineering Design, Sustainable Design Education, Internationalizacion, Design Education

### **INTRODUCTION**

Since 1991, the Universitat Politècnica de Catalunya (UPC) has focused on introducing Sustainability education in all its engineering and architectural programs through two environmental plans (1996-2000, 2000-2005), and currently through the UPC Sustainable 2015 [1] plan.

In 2009 UPC has introduced engineering design of product development degrees education at Bachelor level and in 2017 it is starting its first master degree in design. Due to its experience in embedding sustainability in the engineering degrees, when designing all this degrees sustainability has been at the core of the competences to be acquired by students.

Next sections will present the experience at undergraduate education where a minor in Sustainable Design, International Design Project Semester, at the School of Engineering of Vilanova I la Geltrú (EPSEVG) has been run since.

## **1 INTERNATIONAL DESIGN PROJECT SEMESTER**

The International Design Project Semester (IDPS) is a 30 ECTS minor offered at Engineering Design and Design students that are finishing their undergraduate studies. Learning outcomes

### **1.1 Minor structure**

The IDPS is a unique program in this respect and is totally adapted to the European Higher Education Area and is suited to Bachelor Design Engineering students in their final study semester. In brief, the program has the following characteristics:

- It is international and multicultural;
- It is for Industrial Design Engineering students
- English is the working language;
- It addresses the real needs of companies;
- It is an intensive, one-semester program;
- It is worth 30 ECTS credits;
- It works out the Sustainability competences.
- It combines both face to face and distance teaching methods (blended learning).

The IDPS has three complementary parts:

Part one: A project (18 ECTS): During the semester and under the guidance of an academic tutor, an international team of four to six students works on a real-life project for a Spanish for an international company. The teams are made up of students from an Industrial Design Engineering background from Europe and beyond. Individual and group tutorials are offered during the semester.

Part two: Core courses (12 ECTS): Four courses are offered, Eco-Design, Human Centred Design, Sustainable Value Design and a fourth course which varies from year to year to adapt to the demands and profiles of each program. Students are awarded 3 ECTS for each of them.

Part three: Seminars: short intensive practical workshops on topics related to sustainability, advertising, product system services etc. are also offered to broaden the students' vision on sustainability and to enhance the work related to the project. These complementary workshops also help students develop their communication and cooperation skills.

The projects are real-life projects proposed by companies. The project proposals from the companies must meet the following criteria:

- Sustainable in focus:
- Complexity: final year Bachelor students should be able to carry out the project.
- Difficulty: the project can be completed in 15 weeks.

- Supervisor: the company has to provide a supervisor and facilitate all the information needed to carry out the project in English.

The IDPS structure and agenda is illustrated below (Figure 1). The program lasts 15 weeks and the final week, week 16, is given over to evaluations, examinations and oral presentations: students deliver their assignments for the courses, submit their final report –scientific paper- and a poster on the project and present their conclusions orally in front of a scientific evaluation committee.

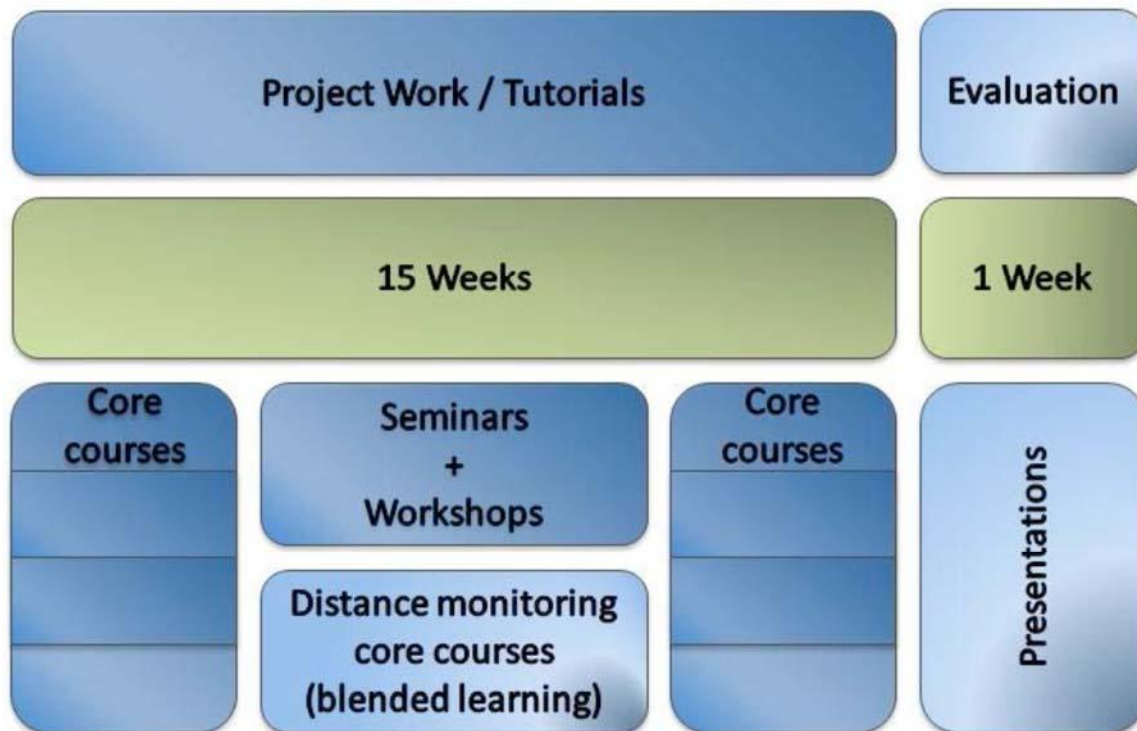


Figure 1: Schedule of the IDPS

Fig. 1. Blended learning Schedule structure of IDPS

Project work begins when the program starts and lasts its entire length. The courses are split into two main blocks; one at the beginning and the other towards the end of the program. The interim period allows students time to continue developing the project, attend the additional workshops and seminars and interact with the course teachers using virtual platforms such as the digital campus, Skype, Wikis etc.

To make the project recognized for students, learning portfolio Erasmus mobility agreements are signed between universities with design degrees.

## 1.2 Projects

The projects are proposed by companies and are “modulated” by faculty in order to assure that project fit learning outcomes and competences of students involved.

Table shows a typical description of a project once it has been approved to be run at the IPDS program

Table 1.Exemple of Project description

**Project**Title: (Title and pictures related to the project)

Paediatric and neonatal lung simulator

Introduction: (Explain the framework of the project and the problem to be solved)

The objective is to design a neonatal/paediatric lung simulator. These devices are useful both for research and educational purposes.

Nowadays there exists a wide variety of them from very simple ones, even homemade with garden connectors to very sophisticated ones like SIMVENT.

Former lung simulators are designed for research studies in order to check ventilator capabilities. On the other hand, simple lung simulators are used basically for educational purposes; they are cheap and even easily constructed. Unfortunately, these simulators are not very precise or reliable to create standard clinical scenarios, so the professor sometimes faces simulation problems during hands-on sessions.

Project Brief: (Describe the project specifying the main objective and its outcomes, design specifications, etc...)

Design a lung simulator for educational purposes able to create standard clinical situations like decrease of compliance, increase of resistance or leaks in neonatal and paediatric scenarios. The lung simulator has the following different parts:

- Design of the mechanical device transportable in a small suitcase. Two sizes of lungs available. Neonatal (25-50 ml) and paediatric lungs (125-250ml)
- Internal mechanism (resistance, etc) to generate pre-defined common clinical scenarios with several degrees of severity

A concept prototype of the device has already been developed by students of the precedent IDPS. The challenge is to continue developing the project so as to deliver, test and validate a fully operational prototype that could eventually be used in a real-field environment. To meet this challenge, performance by the prototype should allow for:

- Connection to different sizes of lungs
- Generation of changes in compliance and resistance
- Remote wireless operation by the instructor through an application running on a mobile device (smart phone or tablet)
- Testing and validation in a real-field simulation environment

**Company**

<u>Name:</u> Children's Hospital Sant Joan de Déu
<u>Address:</u> Ps. Sant Joan de Déu, 2. 08950 Esplugues de Llobregat
<u>Contact person:</u> (name, e-mail, phone number) XXX

### 1.3 Six years' experience results

The IDPS program started in 2012, and we are now running its 6<sup>th</sup> edition. During the five years of the program 48 engineering design students from 12 nationalities have participated in the program (Figure 2), ensuring the internationality and inter-cultural learning of the program. Students have worked in 15 real projects related to all kind of sectors: ICT, furniture, robotics, domestic appliances, industrial machinery, buoys for marine industry, etc. (<http://www.epsevg.upc.edu/idps/idps-course/projects-from-previous-idps-programmes>)

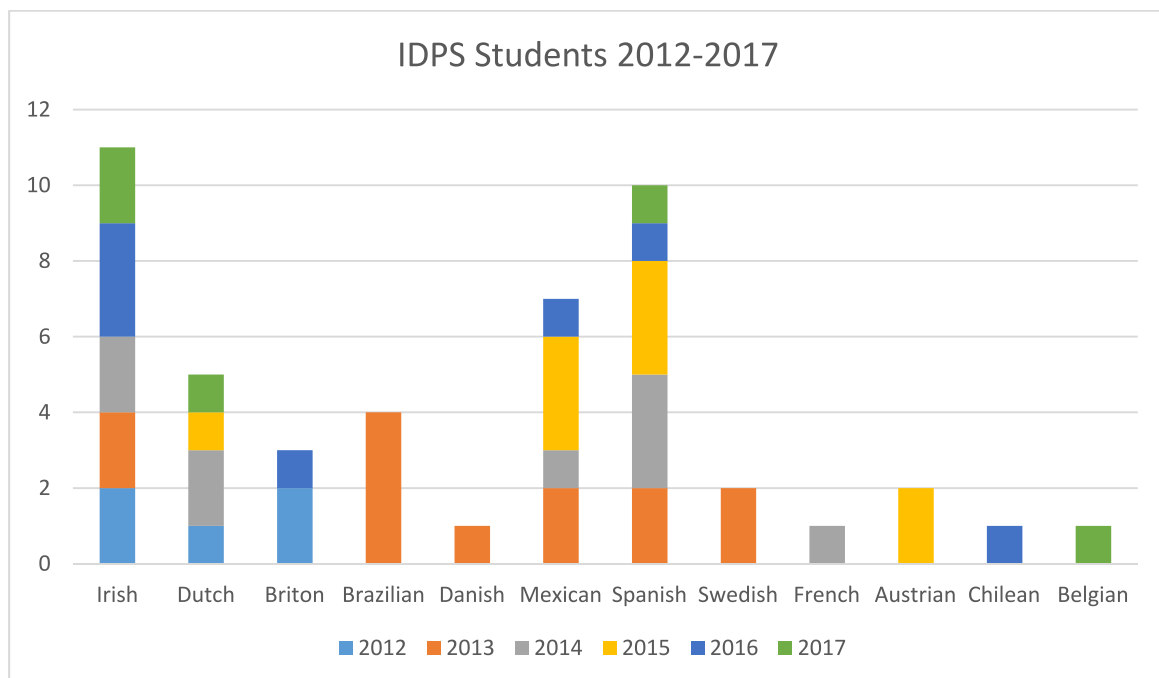


Fig. 2. Students participating in the IPDS program

Participating students were asked to complete questionnaires to provide the EPSEVG with feedback on the course and to show where improvements could be made. The questionnaire used is the Students' Evaluations of Educational Quality (SEEQ) questionnaire [2]. It measures nine distinct components of teaching effectiveness that have been identified in both student ratings and faculty self-evaluations of their own teaching. Figure 3 illustrates the results from these questionnaires, where we can see the high level of satisfaction of student for all courses.

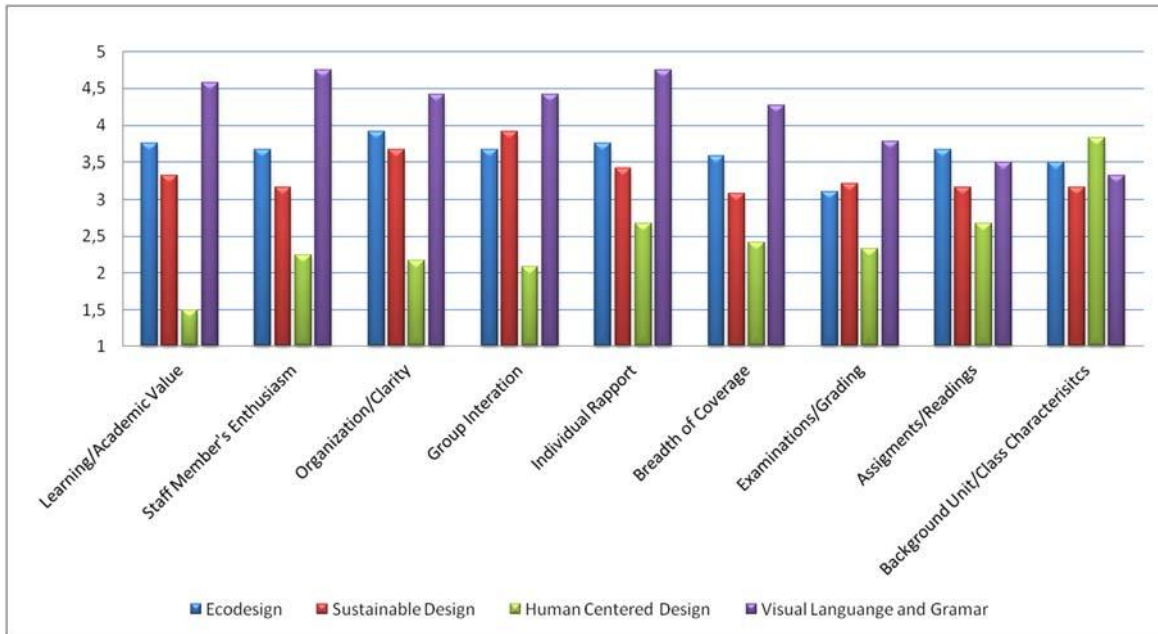


Fig. 3. SEEQ Courses evaluation by students

## 2 CONCLUSIONS

This paper has introduced an undergraduate example of engineering design for sustainability at UPC Barcelona Tech. The experience show a minor (30 ETCS) for final year Engineering Design students at bachelor level.

The author highlights that using community oriented and constructive learning approaches [3], where students work most of the time in real projects proposed by companies is crucial for sustainability education in general and specially in Sustainable Design education.

## 3 ACKNOWLEDGMENTS

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